should be repeated in a work of this kind. For example, Violle's value for the melting point of gold is given as it was printed in his original paper in 1879—namely, 1035° C. Two years later (*C.R.*, xcii. p. 866) he stated that this was a printer's error for 1045° C. Still later he admitted that the value 1045° needed raising 15° or 20°, thus bringing his figure into complete accord with the results of modern observers. Yet no mention of these facts is made in the book, nor is any account taken of the influence of this raising of the melting point of gold on the results obtained for numerous other substances, using pyrometers standardised by this melting point.

Again, several papers by American physicists have been written on the correction of Rowland's classic experiments on the mechanical equivalent of heat to bring his temperature-scale into agreement with modern standards; yet we find the values of Rowland's original paper given on p. 810 without comment.

In the table of dielectric constants the duration of the charge should have been specified, and the same applies to the table giving the resistance of insulators, where both the testing voltage and time of electrification are vital in determining the value obtained. In spite of many omissions, the book is the most complete and best of its kind, is well bound and printed, and should be found in every well-equipped laboratory of physics or chemistry. J. A. HARKER.

THE PRINCIPLES OF SCIENCE.

Erkenntnis und Irrtum. By Prof. Ernst Mach. Pp. 461. (Leipzig: J. A. Barth, 1905.) Price 10 marks.

PROF. MACH is best known to English readers by the translation of his "Die Mechanik in ihrer Entwickelung." Those who have read that admirable book and know its interest will probably hasten to learn more of that philosophy of science which is only dimly indicated therein in a few casual but suggestive remarks. Perhaps they will be disappointed.

For Prof. Mach is no philosopher; he is a "Naturforscher"; he assures us of it at every opportunity; the mere name of philosophy fills him with horror. But unfortunately a hatred of other metaphysicians is not unknown among those included under the same name; it is just as metaphysical to condemn metaphysics as it is superstitious to belong to the "13 Club." A new answer to the problems of metaphysics does not exclude us from the circle of students of that subject, for only by ignoring those questions can we place ourselves outside it; whoever deals with such problems must be treated as a philosopher.

Prof. Mach's views on the philosophy of science are very similar to those which Prof. Pearson expresses in his "Grammar of Science"; his attitude approaches more nearly to sensationalism than to any other recognised system. Our sense impressions are for each of us the only ultimate facts and the only source whence knowledge can be derived. Science consists in the adaptation of our thoughts to one another, a process in which an essential part is played by the conceptions which we form by generalising our perceptions. Knowledge, therefore, is attained in the simplification of our conceptions and in their harmony with our perceptions. No knowledge exists which is not scientific; we can deal with nothing but phenomena; "things in themselves" are meaningless, they are "monströse, unerkennbare." Causality is a conception derived from the constancy of association of some of our perceptions, and is nothing but a functional relation between phenomena. Geometry and other branches of pure mathematics consist of the study of the conceptions of space, time, number, and so on, to which we have been led by a study of phenomena and a consequent idealisation of our perceptions; the possibility of intuitional knowledge must be absolutely rejected. Such are the chief propositions which the author is concerned to establish.

It is clear that these propositions were designed to meet the needs of a student of natural science, and that only those assumptions have been made which are considered necessary and sufficient to prove them. Of course, this would be perfectly legitimate; it is not only logical, but in many ways advantageous, to decide definitely what assumptions must be made in order that science may be possible, to make those assumptions and to leave to others the discussion of their validity and their source. But our author has been in such a hurry to get within the fortress of science and to shut out the hostile metaphysician that he has left some of his necessary baggage outside; his assumptions are not sufficient for his purpose. Knowledge, he says, consists in the perfect harmony of our conceptions and perceptions; that is simply a matter of definition; but then he tells us that this knowledge can give us an expectation (Erwartung). Now our conceptions are derived from past perceptions, and if they are to give us any information about future perceptions it must be on the grounds that future sequences are likely to resemble past sequences. But this is a new proposition; we cannot prove it from "Naturforschung," for Prof. Mach admits that the only method which is available for the attainment of new knowledge by such a process is "incomplete induction," which involves the truth of this very proposition. We must either assume it or deduce it from some other source; for instance, we might deduce it from the uniformity of the observing self and plunge into Solipsism, or from the uniformity of some external agent and be forced to dispute with the metaphysician the questions of reality and existence.

The most satisfactory portion of the book is that in which the methods by which science has been advanced are analysed in detail and illustrated by some apt examples. The chapter on hypotheses directs attention to a sadly neglected principle. The cause of the fruitlessness of Baconian induction in the hands of its author and his followers lay in their neglect of hypotheses. Random experiments, however numerous, are always in vain; except by chance, no researches which have not been directed to the examination of some hypothetically suggested theorem have yielded any useful knowledge.

On the other hand, the psychological investigation into our reasoning powers does not seem very interesting or convincing. Prof. Mach's treatment is genetic, and must always be open to the objection that it is not necessary in intellectual development that the growth of the individual should repeat the history of the growth of the race. Indeed, the influence exerted on our present thought by the few men of real genius is so great as to preclude at once the biological analogy. We regret to see that Prof. Mach in his treatment of time and space makes no mention of the work of Poincaré; he seems to be struggling with difficulties that have been solved already by that brilliant author. Much of the last few chapters would become superfluous if it were recognised that changes in time and space are only phenomenal changes to which we are led to attribute special importance because of their relation to other classes of mental facts which are summed up as "will" and "memory."

Any judgment of a philosophical treatise must depend on the opinions of the reader. The author's exposition is lucid, though all writings in German tend naturally to cumbrousness. It is probable that some will find in this volume valuable ideas which are new to them and suggestive illustrations of those with which they are familiar; but others will prefer Prof. Mach the mathematician to Prof. Mach the philosopher. N. R. C.

MATHEMATICS FOR SCHOOLS.

The Winchester Arithmetic. By C. Godfrey and G. M. Bell. Pp. ix+199. (Cambridge: University Press, 1905.) Price 3*s*.

A Text-book of Algebra. Part i. By A. E. Layng. Pp. viii+176. (London: Blackie and Son, Ltd., 1905.) Price 2*s*. 6*d*.

An Introduction to Algebra. By R. C. Bridgett, F.C.S. Pp. 95. (London: Blackie and Son, Ltd., 1905.) Price 1*s*.

Elementary Modern Geometry. Part i. By H. G. Willis. Pp. viii+236. (Oxford: Clarendon Press, 1905.) Price 2*s*.

Tables and Constants to Four Figures. By William Hall. Pp. ix+60. (Cambridge: University Press, 1905.) Price 3*s*. net.

MESSRS. GODFREY AND BELL'S excellent arithmetic consists mainly of sets of exercises, many of them oral, very carefully graded, and charmingly fresh and varied. A large number of the exercises refer to interesting current events and subjects, and thus incidentally impart quite a fund of general and useful information to the young reader. The metric system is in constant use along with the more important British measures, and by its aid decimals are taken before vulgar fractions. Commercial arithmetic is ably dealt with, but is not allowed an undue monopoly. The needs of the worker in the laboratory are not overlooked, for the course includes approximations, the mensuration of simple plane and solid figures, logarithms, with a chapter on graphs, while symbols and formulæ are introduced from the first, "exhibiting algebra as shorthand arithmetic." The student is not allowed much chance of working unintelligently by rule, and is everywhere encouraged to think for himself, for the rules and processes are left to be given orally by the teacher, who can obtain a special interleaved copy of the book containing model exercises and all the answers. This admirable text-book will rank high amongst its fellows, and it would be difficult to find a school arithmetic more worthy of general use.

In part i. of the algebra by Mr. Layng, the subject is developed in very easy stages, generalising from arithmetic, and is carried up to the solution of simple quadratic equations. In choice of matter the author gives preference to parts which have an immediate practical application, as being specially suitable for young beginners. Graphs are very freely used. The applications include the mensuration of plane geometrical figures.

The algebra by Mr. Bridgett proceeds on somewhat similar lines to that just noticed, but the explanations are briefer, and only simple equations are dealt with. The applications include proportion, profit and loss, simple interest, discount, mixtures, work, averages, areas and volumes. Answers to the exercises are given.

Mr. Willis's volume is the first part of what promises to be an important text-book of elementary pure geometry, representing the present position of the science. The first chapter is experimental and practical, with the object of making the student familiar with the things he is about to study. Chapter ii. deals with first principles. Here the definitions, axioms, and methods of geometrical deduction are fully discussed, and fundamental propositions relating to lines, angles, and triangles are established. In addition to the usual axioms, the author gives axioms of continuity, displacement, and rotation. The next chapter is a short one, containing problems and graphs. The last chapter treats of parallels. Playfair's axiom is introduced as an alternative to the rotation axiom, and reasons are given for not adopting Euclid's criterion of parallelism. Notions about limits, infinity, loci, &c., are introduced and used in the propositions, so that the student acquires these comparatively early in his course. The present part is intended to cover the ground required for ordinary pass examinations, and the forthcoming part, it is hoped, will be suitable for honours. Sets of exercises are given at short intervals, the answers to those which are numerical being collected at the end. The book is one that should be known to all teachers, and is likely to be used by many.

The four-figure tables by Mr. Hall comprise square roots, squares and reciprocals, the ordinary logarithms and anti-logarithms of numbers, and the usual logarithmic and natural functions of angles. In addition, there is a useful three-figure traverse table, occupying eighteen pages, giving the products of all numbers from 10 to 99 into the sines and cosines of angles from 1° to 89°, with intervals of 1°. There are also tables of natural and logarithmic haversines, or half-